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in the automotive field due particularly to the inherent optical and energetic limitations of this type of coating.

b) Sputtered single silver layer coatings, obtained by sputtering a silver containing layer on to a supporting substrate. Such coatings usually comprise a coating stack having the general form: supporting substrate/ antireflective layer/ optional barrier layer/ silver containing layer/ optional barrier/ antireflective layer. In such a structure the silver containing layer serves to reflect radiation in the infra red portion of the spectrum, the antireflective layers serve to reduce reflection of light in the visible portion of the spectrum that would otherwise be caused by the silver containing layer and the optional barrier layers serve to protect to silver containing layer either during deposition of the coating and/or subsequent processing. Whilst the optical performance of single silver layer sputtered coatings is reasonably good such sputtered coatings are generally "soft" coatings i.e. they are not particularly resistant to abrasions and scratches and require significant care in handling to avoid damage. In addition, significant care in both the design and handling of such layers is required to enable them to be sufficiently heat resistant to allow tempering and/or bending of a substrate to which they are applied.

c) Sputtered double silver layers obtained by sputtering two, spaced silver layers onto a supporting substrate. Such coatings usually comprise a coating stack having the general form: supporting substrate/ antireflective layer/ optional barrier layer/ silver containing layer/ optional barrier layer/ antireflective layer/ optional barrier layer/ silver containing layer/ optional barrier/ antireflective layer. In such a structure the silver containing layers serve to reflect radiation in the infra red portion of the spectrum, the antireflective layers serve to reduce reflection of light in the visible portion of the spectrum that would otherwise be caused by the silver containing layer and the optional barrier layers serve to protect to silver containing layers either during deposition of the coating and/or subsequent processing. The infra red reflective silver containing layers are commonly layers of silver or a silver alloy have a thickness in the order of 80 to 120 Å. The optical performance of double silver layer sputtered coatings can be extremely good, especially in terms of their selectivity but perhaps even more so than with single silver sputtered coatings these coatings are extremely fragile both in terms of resistance to abrasions and scratches (for example during handling) and in their ability to withstand heating for example to enable them to be sufficiently heat resistant to allow tempering and/or bending of a substrate to which they are applied.

One example of the use of sputtered coating layers in automotive applications is US Patent N° 4,668,270 (Ford Motor Company) which describes a car

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windscreen having an electrically heatable coating layer used for defrosting, de-icing and/or de-misting. The heatable coating, which is laminated between the two glass sheets of the windscreen, is supplied with electrical power via first and second bus bars which extend respectively along the top and bottom edges of the windscreen, each bus bar being silk screen printed on the glass in a silver ceramic material. The heatable coating is a multilayer coating consisting of zinc oxide and silver formed by magnetron sputtering.

The physical nature of double silver layer coatings layers is entirely different to that of, for example, pyrolytic coating layers and, consequently, entirely different techniques must be employed for their design, processing and use.

It has generally been believed in the art that the precautions of the techniques described below must be adhered to to enable the successful use of sputtered double silver layers in laminated automotive glazings:

1) that the sputtered double silver layers should be deposited on a carrier film of, for example pet (poly ethylene tetrachloride), which is assembled between the two glass sheets of a laminated glazing once the individual sheets have been bent to their desired final shape. One disadvantage of such carrier films is the difficulty of ensuring that the film correctly follows the precise contour of the bent glazing panel. Consequently, this procedure is limited to use with glazing panels of a relatively simple curvature. In addition, it is generally not desirable to electrically heat the solar control coating in such an arrangement due to deterioration of the coating and/or of the carrier film and it is also inconvenient to provide bus bars in this arrangement to relay electrical power to the coating. Consequently, this technique is generally unsuitable for use with heatable windscreens.

2) that, alternatively, the sputtered double silver layers should be applied to the concave face of a <u>pre-bent</u> sheet of glass prior to its assembly to form a laminated glazing panel. In this way, the coating layer is not subjected to the heat treatment necessary to form the desired curvature of the glass sheet. Disadvantages of this technique include the technical difficulty of sputter depositing coating layers onto a curved sheet of glass so as to ensure that the entire glass surface is evenly coated (due, amongst other things, to the variation in the distance between the different parts of the glazing surface and the targets used for the sputtering process - small variations in thickness of the coating layers can cause undesirable colour variations across the glazing panel) and the complexity and limitations (including dimensional limitations- complex windscreens having deep curvatures will not always fit in to such coating machines simply because of their dimensions) of coaters which can sputter deposit layers onto a curved substrate. Consequently,

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this technique is also limited to use with relatively simple curvatures of glazing panels.

3) alternatively, sputter depositing a double silver coating layer onto a relatively flat sheet of glass and subsequently bending the glass sheet carrying the coating stack to its desired shape prior to assembly as a laminated glazing panel. Due to the fragility of this type of coating, the glass sheet carrying the coating stack should be bent such that the coating stack is at the concave face of the curved sheet of glass. This is so that the layers of the coating stack have a tendency to be compressed during the bending process so as to ensure the integrity and continuity of the layers of the coating stack; this is particularly so for complex curvatures of glazing panels.

Thus, in order to successfully use a sputtered double silver layer coating on a complex curved glazing panel it is necessary either to deposit the coating onto a pre-curved glazing panel or to use a heat treatable sputtered double silver layer coating deposited on a substantially flat sheet of glass which is subsequently bent so that the coating is at its concave surface.

According to one aspect, the present invention provides a method of making a laminated automotive glazing panel as defined in Claim 1.

The invention results from the unexpected realisation that despite prejudice in the art, a complex shape of glazing panel incorporating a sputtered double silver layer coating may be produced on an industrial scale by depositing the coating on a substantially flat sheet of glass and subsequently bending the glass sheet carrying the coating such that the coating is at the convex surface of the glazing panel. This is possible despite the fact that subjecting the sputtered double silver coating layer to the tension and extension inherent in bending it into a convex shape would be expected to destroy the integrity and continuity of the coating layer and perhaps even to result in significant disparities in the thickness of the coating layer over the area of the glazing panel. The realisation that this is possible with relatively complex curvatures is even more surprising firstly because complex curvatures require significant degrees of bending and would thus be expected to cause unacceptable tension and extension of the coating layer and secondly because complex curvatures require the heating of the glass substrate to a softening level at higher temperature and/or for a longer duration that simple curvatures and would thus be expected to put additional unacceptable strains on the relatively fragile sputtered double silver coating layer.

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One factor which may be used to define the complexity of curvature of an automotive glazing is the radius of curvature. The smaller the radius of curvature, the more difficult it becomes to accurately and repeatably bend the glazing panel.

The present invention may be used in association with glazing panels having a radius of curvature at at least one portion that is less than 450mm, less than 400mm, less than 350mm, less than 300 mm, less than 250mm, less than 200mm , less than 150mm or even less.

According to another aspect, the present invention provides a method of making a laminated automotive glazing panel as defined in Claim 3.

Another factor that may be used to define the complexity of curvature of an automotive glazing panel is its cross curvature. This is a measurement of the depth of curvature across the height of the glazing at the central portion of the glazing panel.

The present invention may be used in association with glazing panels having a cross curvature that is at least 15mm, at least 20mm, at least 25mm, at least 30mm, at least 35mm or greater.

The curvature of the glazing panel becomes even more complex when, for example, a significant minimum radius is combined with a significant cross curvature.

A further factor which may add to the complexity of curvature of an automotive glazing panel is the depth of bending. This is a measure of the greatest distance between the front face of the glazing panel and the end of the rearwardly projecting side wings of the glazing panel. The present invention may be used in association with a depth of bending of at least 150mm, at least 170mm, at least 190mm, at least 200mm, at least 220mm, at least 240 mm, at least 250mm or more. The complexity of curvature is further increased if a significant depth of bending is combined with a significant minimum radius of curvature and/or a significant cross curvature.

The present invention may advantageously be used to provide a de-misting and/or de-icing function to the glazing by using a coating layer which is electrically heatable and providing a pair of spaced bus bars to relay electrical current to the coating layer. The exposed concave surface of a laminated windscreen is generally at the interior of the vehicle. Positioning the coating layer on the convex surface sandwiched between the two glazing panels of the laminated structure may provide a number of advantages with respect to positioning a heatable sputtered double silver coating layer at the concave surface sandwiched between the two glazing panels of the laminated structure. These may include:

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a) an improved de-misting function as the heatable coating layer is directly adjacent to the sheet of the glazing panel at the interior of the vehicle;

b) a reduced risk of damaging the integrity of the coating layer in the case of a small breakage or crack of the outer sheet of the glazing panel, for example due to the impact of gravel. Any discontinuity in the coating layer may cause a break in its electrical conductivity and a consequent overheating of immediately surrounding areas of the coating layer when electrical current passes. Such overheating may cause deterioration of the coating layer and/or deterioration of the laminating film between the two sheets of the glazing panel. In addition, the position of the coating protects it at least to some degree from the risk of corrosion by the ingress of moisture in the case of a breakage or crack in the outer sheet of the glazing panel.

An additional advantage of the defined positioning of the coating layer in association with the provision of bus bars is the ability the hide the bus bars from view from the exterior of the glazing panel by providing a substantially opaque masking layer, for example a black enamel layer, around a portion of the internal, concave surface of the glazing panel.

The complexity of curvature is increased in respect of glazing panels having a significant width, for example, glazing panels that are between 1.2m and 1.4m wide, or between 1.4m and 1.6m wide or between 1.6m and 1.8m wide.

The invention may be particularly suitable for use in relation to vehicle windscreens.

The glazing panel may have a luminous transmittance of greater than 70% or greater than 75%. This may enable its use as a windscreen.

The glazing panel may have a neutral colour in reflection from its exterior surface, a slightly blue colour or a slightly green colour. This may render it particularly suitable for use in automotive applications. In particular, the colour of the glazing panel in reflection from the exterior may be such that its colour co-ordinates measured on the CIElab scale at normal incidence are:

$L^*=40 \pm 3$ $a^*=-6 \pm 3$ $b^*=-8 \pm 4$ (this is intended to give a blue tint in reflection, particularly for a windscreen installed at an angle); or

$L^*=39 \pm 3$ $a^*=-6 \pm 3$ $b^*=-2 \pm 2$ (this is intended to give a green tint in reflection, particularly for a windscreen installed at an angle); or

$L^*=36 \pm 3$ $a^*=-5 \pm 2$ $b^*=-4 \pm 2$ (this is intended to give a neutral/green tint in reflection, particularly for a windscreen installed at an angle);

The variation is colour in reflection over the surface of the glazing panel may be such that when measured at different points over a single glazing, the

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values of either a* and/or b* measured on the CIElab scale at normal incidence do not vary by more than ±1.5, and preferably by not more than ±1. The variation in colour in reflection is due at least to a significant extent upon variations in the thickness of the film stacks of the coating layer and/or variations in the heating regime during heat treatment over different parts of the glazing. It is perhaps particularly unexpected that such minimal colour variation can be achieved by means of the present invention as it would be expected that extension of the coating layer would stretch the coating layer, at least in some places and/or destroy the integrity of the coating layer and/or render it unstable during heat treatment.

Preferably, the variation in colour in reflection between one glazing and another is such that the values of either a* and/or b* measured on the CIElab scale at normal incidence do not vary between one glazing and another in a series of glazings by more than ±2, and preferably by not more than ±1.5.

Arranging the resistance of the heatable coating layer to be between about 1.5 and 4 ohms per square may provide particularly suitable heating characteristics for automotive use. Similarly, arranging for the resistance between the bus bars to be between 0.75 ohm and 8 ohm may also provide particularly suitable heating characteristics for automotive use.

According to further aspects, the present invention also provides a curved laminated glazing panel, as defined in claims 15 and 17, and for the use of a sputtered double silver coating layer deposited on a substantially flat sheet of glazing material and subsequently bent into a convex configuration to provide a glazing panel as defined in claim 29.

The glazing material onto which the solar control coating layer is deposited may be a sheet of glass. It is preferably a soda-lime glass, more preferably float glass. It may comprise the following constituent (expressed in percentage by weight):

SiO_2	60 to 75%
Na_2O	10 to 20%
CaO	0 to 16%
K_2O	0 to 10%
MgO	0 to 10%
Al_2O_3	0 to 5%
BaO	0 to 2%
BaO+CaO+MgO	10 to 20%
K_2O+Na_2O	10 to 20%

An embodiment of the present invention will now be described, by way of example only, with reference to: